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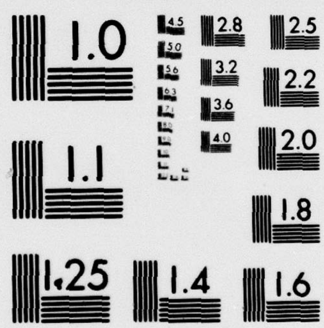

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF

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WOODS HOLE OCEANOGRAPHIC INSTITUTION

Woods Hole, Massachusetts

(14) WHOI-REF-50-13

(9) Periodic status rept. no. 14,
1 Oct - 31 Dec 49.

(12) 19

Reference No. 50-13

(6) OCEANOGRAPHIC RESEARCH

conducted during the period

October 1, 1949 - December 31, 1949

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

Periodic Status Report No. 14
Submitted to the Oceanographic Division
Hydrographic Office
Under Contract No. (15) N6onr-277
Task Order No. I, NR-083-004
with Office of Naval Research

(11) Mar [redacted] 50

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Director

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According the the terms of Contract N6onr-277, Task Order No. I, NR-083-004, the work to be performed by the Contractor shall consist of the following:

1. The Contractor shall furnish the necessary personnel and facilities for, and, in accordance with any instructions issued by the Scientific Officer or his authorized representative shall

(a) conduct surveys and research, and analyze and compile data and technical information, prepare material for charts, manuals and reports, and foster the training of military and civilian personnel in the following fields of oceanography;

(i) permanent currents;

(ii) interaction of the sea and atmosphere, including wind waves, swell and surf;
(iii) distribution of organisms;
(iv) characteristics of the sea bottom and beaches;
(v) tides, tidal currents and destructive sea waves; and
(vi) physics and distribution of sea and terrigenous ice*;

and perform the following work in particular;

(1) (Confidential)
(2) collection of analyses of bathythermograph observations**; and
(3) conduct of a wave measurement program in the Atlantic.

* Research in connection with relations between North Atlantic sea ice and Arctic weather was transferred to Task Order V of Contract N6onr-277 on May 15, 1949 and will be reported in a separate Periodic Status Report.

** The tabulation and filing of bathythermograph observations was transferred to Task Order VI of Contract N6onr-277 on May 15, 1949. Observations received and processed during the fourth quarter of 1949 have been reported in a separate Periodic Status Report covering Task Order No. VI (Reference No. 50-7).

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ABSTRACT

This report contains a quarterly summary of work carried out ~~under Contract N6onr-277, Task Order No. I~~ by the Woods Hole Oceanographic Institution under the following headings:

ABSTRACT

Papers Published

"The Principles of Time Series Analyses Applied to Ocean Wave Data", Proc. Nat. Acad. Sci., Vol. 35, No. 9, pp. 518-528, Sept., 1949, by Dr. H. R. Seiwell.

Papers Submitted for Publication

"The Water Structure in the Brownson Deep" by Mr. M. J. Pollak has been submitted to the Trans. Amer. Geophys. Union for publication.

"Problems in Statistical Analyses of Geophysical Time Series" by Dr. H. R. Seiwell has been submitted to Science for publication.

"A New Mechanical Auto Correlator" by Dr. H. R. Seiwell has been submitted to Review of Scientific Instruments for publication.

Papers Presented at American Society of Limnology and Oceanography

"Behavior of Tides in Embayments" by Dr. A. C. Redfield.

"Some New Results on the Behavior of the Gulf Stream System" by Dr. W. L. Ford (Naval Research Establishment, Halifax, N. S.) and Mr. F. C. Fuglister.

<u>Oceanographic Surveys off East Coast of U. S. between Miami, Florida, and Cape Hatteras</u>

The drafting of temperature, salinity and density profiles of the CARYN (#7) and ALBATROSS III (#18, 19, 21 and 22) cruises has been completed as well as areal plots of these qualities at several levels. These data appear to support the general postulate of the non-tidal circulation over the continental shelf off the Carolina bays as outlined in WHOI Reference No. 49-6 by Bumpus and Wehe.

Figure 1 indicates the seasonal progression of temperature and salinity over the region.

A careful study of the Geological Survey's water supply papers has been made preliminary to an attempt to evaluate the influence of effluent waters in the circulation pattern.

The U. S. Fish and Wildlife Service, WHOI, and the University of North Carolina, Institute of Fisheries Research are planning two further cruises on the ALBATROSS III. The first cruise to be conducted in early January will collect temperature, salinity, oxygen and phosphate data. In addition, drift bottles and drift cards will be released at 50 positions in North Carolina waters. During the second cruise, in late February, temperature and salinity data and bottom samples will be collected and drift bottles will be released.

The excellent results obtained by Dr. Ketchum and Dr. Redfield in the New York Bight area has stimulated us to attempt drift bottle experiments off North Carolina.

It is hoped that this program will bring to bear evidence of varying types, oceanographic, hydrographic and geological, in an endeavor to describe the circulation in North Carolina waters.

This work is being carried out by Messrs. Bumpus, Miller and Hayes with drafting being done by Mr. Pasley.

<u>Arctic Oceanography</u>

Mr. Hoadley and Mr. Owen returned from Point Barrow,

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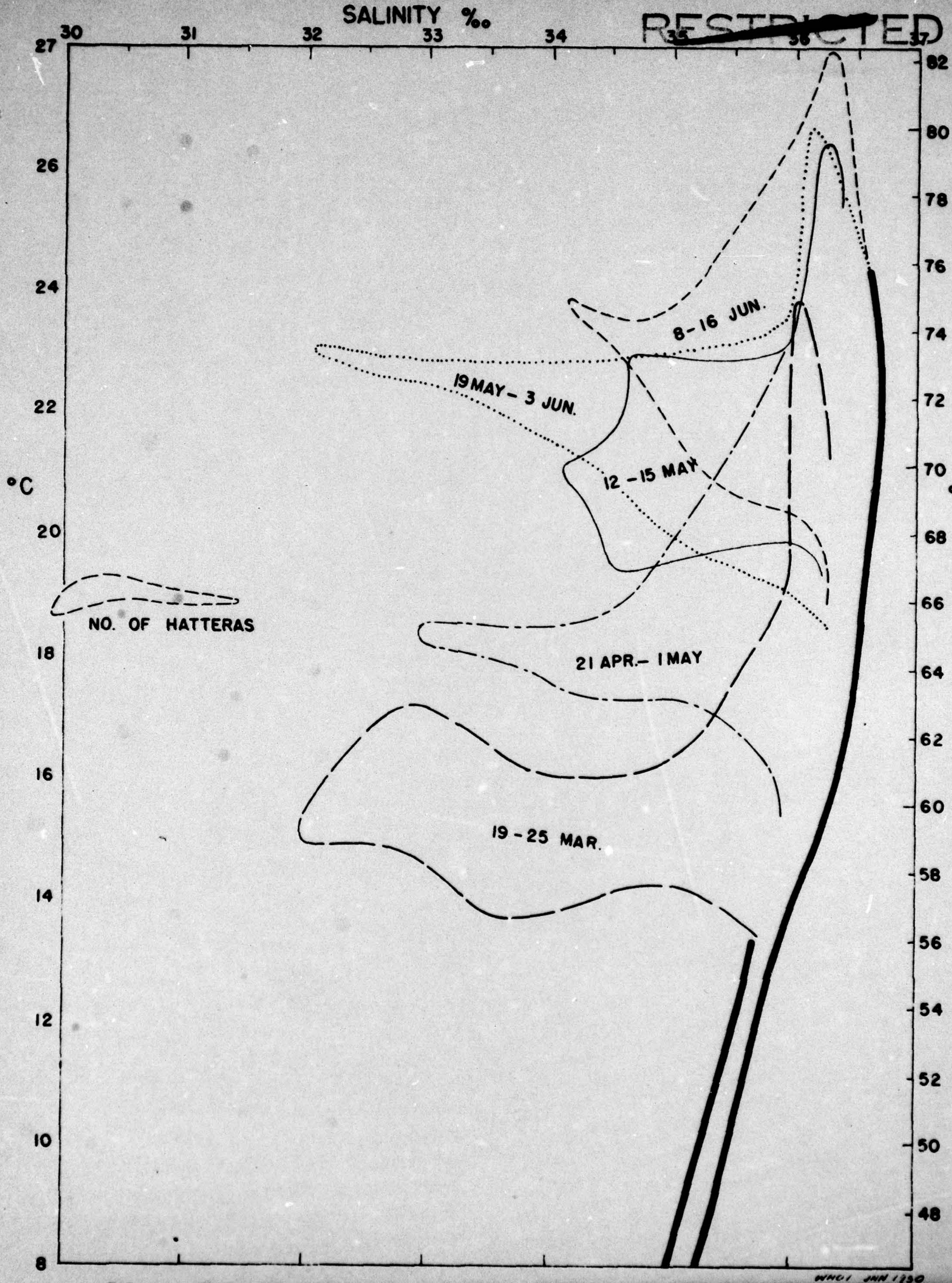

WHOI JAN 1950

FIG. 1 T/S RELATIONS IN CAROLINA WATERS [redacted]

Alaska, in the latter part of December at completion of their two month tour at the Arctic Research Laboratory. Their activities have been reported in informal reports from Point Barrow. Temperature, salinity, ice thickness and ice growth measurements were made in the Point Barrow Camp area and three cruises were made in coastal waters off the Camp area to distances as great as eight miles to measure temperature and salinity. The absence of the ice pack in the immediate vicinity of Point Barrow prevented the study of the growth of pack ice and testing of oceanographic instruments on the ice.

At the end of November, Messrs. Metcalf and Pollak commenced preparations for an arctic cruise on the U.S.S. EDISTO to start in the middle of January 1950. These preparations included a conference with Hydrographic Office and CNO representatives in Washington, D. C., early in December and numerous visits to the U.S.S. EDISTO in Boston, Mass. The gathering of oceanographic equipment and the installation of a suitable hydrographic winch on the ship were the greatest problems.

Salinity Titrations and Calibrations of Thermometers

The following groups of salinity samples have been titrated:

ALBATROSS III, Cruises 21 and 22	242
CARYN Cruises 12, 13 and 14	129
ASTERIAS (New Bedford)	108
U.S.S. MALOY	250
U.S.S. EDISTO	150
U.S.S. CORSAIR	290
BLUE DOLPHIN	300
ATLANTIS Cruise 157	150
U. S. Public Health Service	29
Miscellaneous	10
	1,658

This work has been carried out by three full-time technicians under the supervision of Mr. Pollak.

The following thermometers have been received for calibration:

U. S. Navy Hydrographic Office (for U. S. Coast Guard)	10

Statements of examination have been issued for the following groups of thermometers:

	Index Corr.	Pressure Factor	Vo	Thermometer Unsatisfactory
Hydrographic Office	27	13	3	3
Fish and Wildlife Service (Woods Hole)	4			
WHOI	12			
Bermuda Biological Station	2			
Pacific Oceanic Fisheries Investigation	11			1
	56	13	3	4

It is with deep regret that we announce the accidental death of Edward Penrose who designed and constructed the thermometer calibrating equipment and has so carefully calibrated reversing thermometers.

Mr. Frederick Pingree is learning the techniques of thermometer calibration under the supervision of Mr. Bumpus.

Sea Surface Wave Studies

Research was divided as follows:

1. Construction and testing of new wave measuring equipment.

2. Analyses of sea surface wave records.

3. Experimental correlogram analyses of mathematical models.

In (1) above, equipment was designed to measure wave height variations of less than one inch. Wave poles were built to have alternate black and white, one-inch-divisions. Field tests were carried out in the deeper part of Woods Hole Harbor under a variety of sea states. The poles were maintained in fixed vertical positions by means of weighted baffles and provide the background for photographing sea surface variations with a 16 mm motion picture camera, equipped with a 12-inch telephoto lens, at a speed of 64 frames per second.

The correlogram analysis of a record taken in this test is illustrated by Figure 2. It shows a constant period of 57 frames length equal to 57/64, or 0.89 seconds. The curve damps to a terminal amplitude of $r_T = 0.496$. The

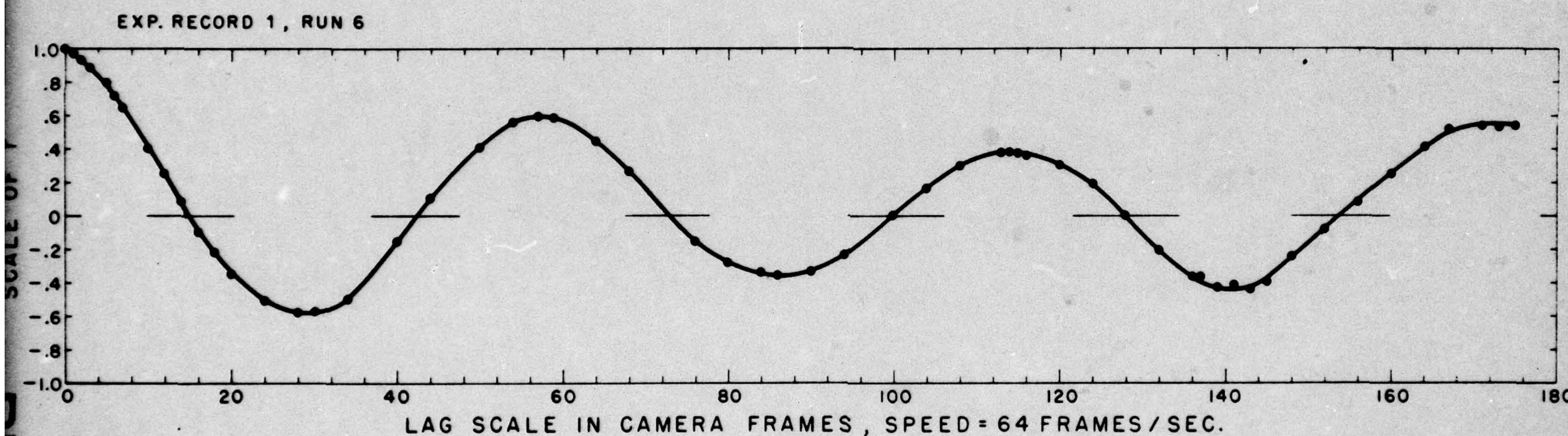
EXP. RECORD 1, RUN 6
1.0
.8
.6
.4
.2
0
-.2
-.4
-.6
-.8
-1.0
0
20
40
60
80
100
120
140
160
180
LAG SCALE IN CAMERA FRAMES, SPEED = 64 FRAMES/SEC.

FIG. 2

amplitude of the 0.89 second trigonometric, obtained by a least square fit to the basic data, is C = 0.664 inches. The correlogram of the residuals, remaining after subtraction of this trigonometric from the basic data, indicates a near random sequence (Figure 3).

In (2) and (3) above, the analyses of summer and fall wave records from several points off Cape Cod have been carried on parallel with a study of experimentally generated models of various combinations of trigonometric, autoregressive and random functions. More than fifty models have been subjected to correlogram analyses and their properties computed for comparison with known parameters. As a result, various limitations and properties of the correlogram have been brought out which aid in the interpretation of similar analysis of natural wave data. It appears that correlogram analysis permits initial identification as to whether the basic series is random, periodic in one term only, periodic in more than one term or completely autoregressive. In the special case where the basic series contains a single sine wave, the correlogram is a cosine curve of that period having equal distances between successive peaks and successive valleys (such as Figure 2) and which damps to a terminal amplitude, the value of the latter depending on the per cent variability of the basic trigonometric to the total data. On the other hand, when the basic series contains several cyclical terms, the correlogram will not have a constant period, distances between successive peaks and successive valleys are not constant, and damping is not consistent over more than two or three cycles. Distinction between the two types of series becomes apparent after two, and not more than four, cycles of the correlogram have been examined. When this latter situation occurs, additional information may sometimes be obtained by a Fourier transform of the auto correlation function into its approximate power spectrum. In the special case of the basic data being completely autoregressive, the correlogram damps to zero after a few cycles.

The mechanical auto correlator has been in constant use (Figure 4). In the computation of auto correlation coefficients, it permits a man-hour reduction to approximately one-fifteenth of that required for hand computation using electrically operated computing machines.

Unattended Oceanographic Instruments

The second model of the three year temperature recorder has been completed and has been given a short test off the

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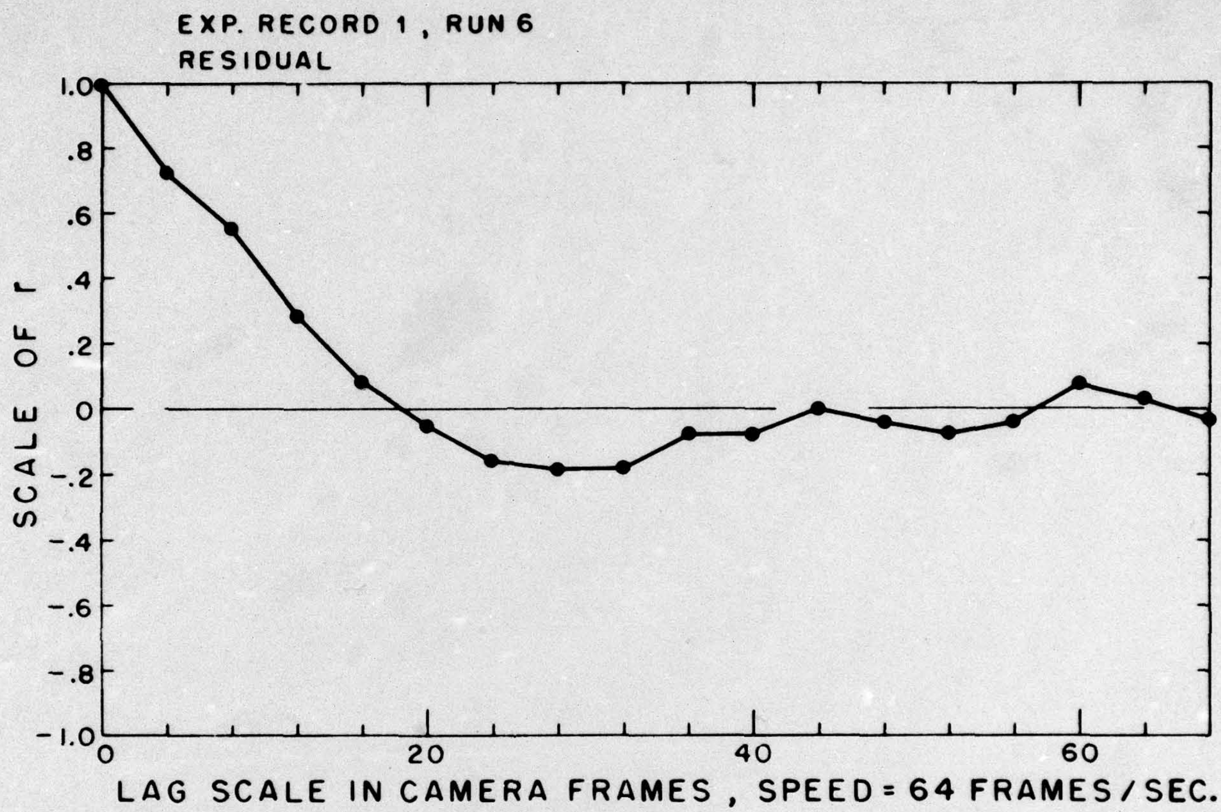

FIG. 3

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FIG. 4

dock. Some very small changes have been made and parts drawings have been completed so that if desired, a number of recorders could be made without delay.

A projector for the Lucite slides is being developed so that an enlargement of the record can be made on 8½" by 11" paper directly from the slide. The slide can be viewed with an eye-piece at the present time. Three views of the instrument are shown in Figure 5.

The recording side of the instrument is shown in Figure 5a. The driving motor for the clock mechanism is shown as A, micro switches for the mechanism as B, recording Lucite slide C, stylus arm D, bourdon and connected capillary E, O-rings to seal cap F. Figure 5b shows additional parts on the under side of the recorder: clock mechanism G, battery supply H, silica gel dryer J, and handle for carrying movement when not in actual recording K. Figure 5c illustrates the instrument in the case, carrying handle removed, showing mooring thimble L.

It has been found that a more reasonable method of attaching to the case will be through an electrically insulated connection. The present change being made is to add a sturdy piece of micarta to the end of the case and anchor a galvanized steel eye in the micarta. This would prevent the connection of steel to brass, which results in rapid eroding of the steel.

The only change in the current meter since the last report is that we are now planning a sawtooth path for the miniature photograph of the compass face to utilize the full width of the film. Each cycle of the sawtooth will occur once per hour instead of once per day as previously reported. It has been found that a good photograph of the compass face, ½ mm high, can be obtained and ten to twelve photographs per hour placed vertically on the film will consume 1/8" of film per hour. This means that the optimum maximum number of recordings per day would be approximately 240, assuming the maximum current velocity, with space for 480 per day if the expectant maximum current is exceeded. The internal parts of the current meter are approximately 20 per cent completed, and we expect to have the first working model finished by March fifteenth.

<u>Electrokinetograph</u> <u>Cruise</u> - Navigation Through a Major Ocean Current

As a test of the effectiveness of the Electrokinetograph as a current measuring instrument, ATLANTIS Cruise 159,

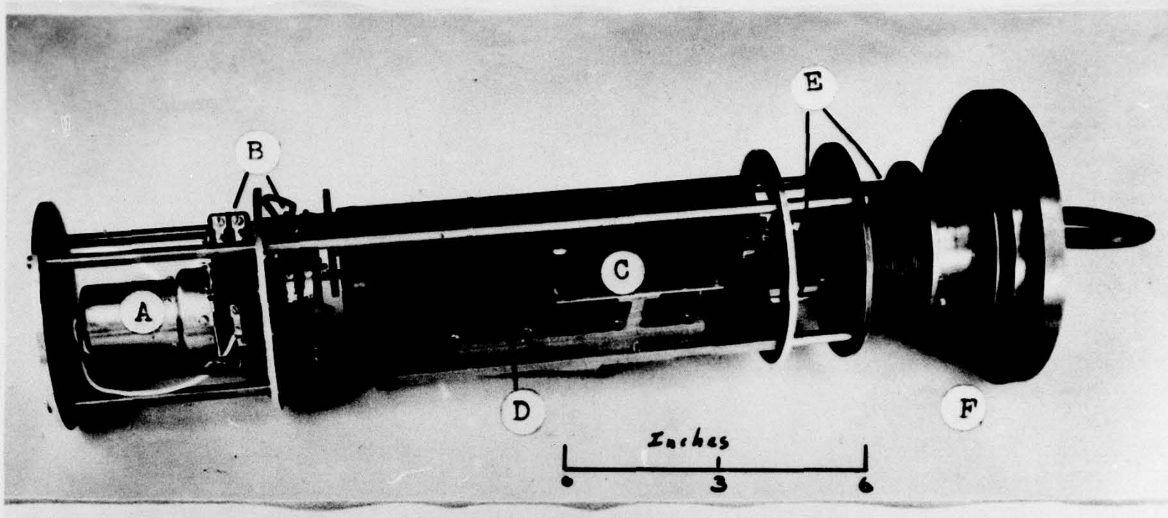

Figure 5a

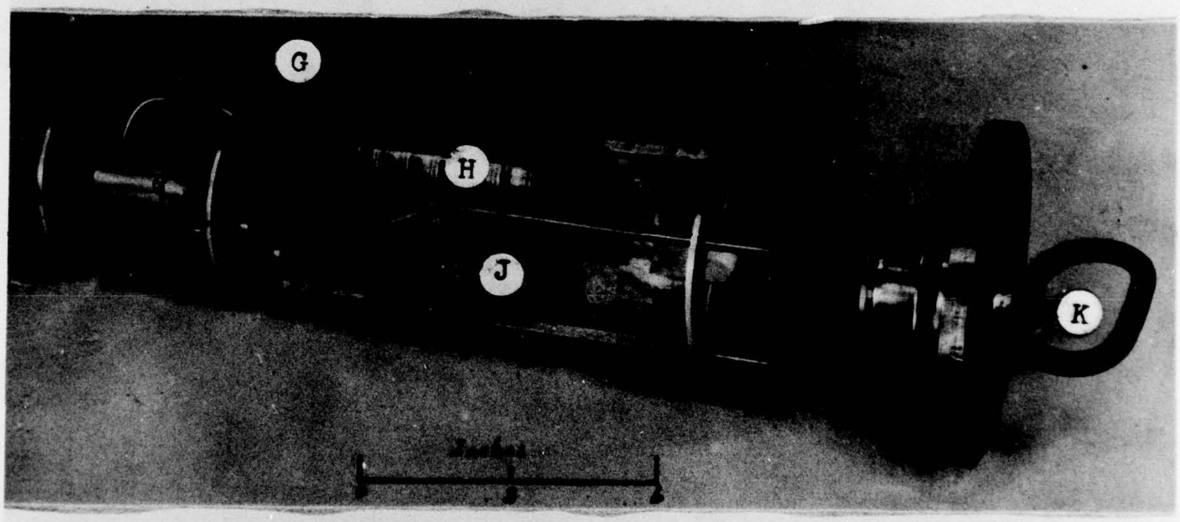

Figure 5b

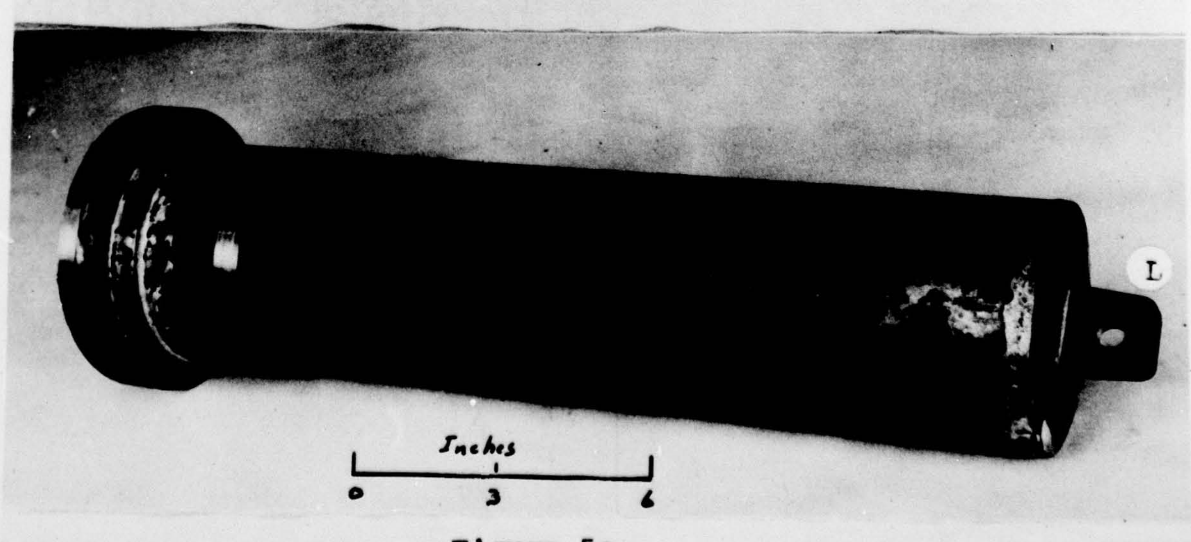

Figure 5c

8-21 December 1949, was spent in an attempt to hold the ship on a segment of the line which cuts the Gulf Stream and joins Montauk Point and Bermuda. In order to run this line, the steered heading of the ship was corrected every hour in such a way that the bow was turned upstream sufficiently to correct for the downstream drift detected by the Electrokinetograph. The angle between the steered heading and the intended course line depended on the velocity of the current and the velocity of the ship. The forward speed of the ship was measured by Pitot meter. To determine the corrected heading, a length proportional to the forward speed was used to close the vector triangle composed of the current vector and the direction of the intended course. The forward speed vector, having known magnitude, and the intended course vector having known direction, the observed current vector permitted the direction of the first and the magnitude of the second to be determined.

The headings steered through the Gulf Stream made angles as great as 54° with the intended course line. The Gulf Stream was crossed twice completely and twice partially during 1006 miles of sailing along a 430 mile line segment. The geographic progress of the ship over the bottom was checked hourly by Loran. Loran data provided geographic control points for the final calculation of the results of the experiment, but these observations were not used in the actual performance of the steering experiment. The rules and assumptions of the experiment were as follows:

1. In order to avoid too frequent course changes with each observed fluctuation of current, the headings, correct at the beginning of each hour, were maintained throughout the hour. Thus, in increasing currents the ship was drifted downstream by an amount proportional to the increase, and in decreasing currents the ship worked upstream by an amount proportional to the decrease. In that approximately the same current systems were traversed in opposite directions, this rule is assumed to have introduced no important systematic errors over the whole cruise, or on corresponding legs in opposite directions, but to have contributed to the random error in the final result.

2. Windage introduces an experimental error in the geographic data obtained by Loran but not in the dead reckoning data of the experiment. Wind will set the ship geographically but only change the direction in which the submerged cable and electrodes are towed. The direction of the interelectrode length differs from the steered

heading by arctan = D/C_s, where D is the rate of lateral drift due to windage, and C_s is the ships speed through the water in the direction steered. Consequently, wind drift is not observed in combination with the measured current except as a small error in direction. Gales from the northeast and north caused considerable geographic drift and eventually forced the ship to heave to for 24 and 47 hours respectively. In order to render the experimental data homogeneous it was necessary to counteract the effects of wind by adjusting the intended line and geographic data as though it too had been drifted by the wind. In this way, the dead reckoning results and geographic results were reduced to terms of the observed current and ships velocity as the principal experimental quantities.

3. A "k" factor of unity was used in all calculations of current at sea in order that a characteristic deep water "k" factor might be determined.

The greatest geographic departure from the intended line was 8.3 miles (15.1 km) due to windage. The average geographic departure from the intended line, excluding windage, was $\pm$ 1.6 miles ($\pm$ 2.8 km). At the end of the experiment the ship passed her initial position at an effective geographic distance of 1.8 miles (3.3 km) downstream. By dead reckoning of the total drift measured by the electromagnetic method, the ship passed her initial position at an effective distance of 52.2 miles (95.2 km) upstream. In that this amount of net progress was made in a direction at right angles to the intended line and the ship closed the course on the opposite side of the intended line, the total drift must have been the sum of the observed drift and the error of closure, 54.0 miles (98.5 km). On the assumption that "k" was unity, the electromagnetic method detected 95.2/98.5 or 96.7 per cent of the true drift. The correct net drift would have been obtained if "k" had been assumed to be 98.5/95.2 or 1.04. The probable error of this result can be estimated from ratio of the average geographic departure from the intended line, $\pm$ 2.8 km, to the total drift, 98.5 km, in which case "k" = 1.04 $\pm$ 0.03. This value is in good agreement with the average of five Class IV determinations, 1.04, made earlier in the same general vicinity, but the scatter of these values is 1.01 to 1.10. It is presumed, therefore, that the raw data from these deep water measurements are, on the average, in error less than 10 per cent, and that if the deep water average, 1.04, has sufficiently general significance to be regularly applied to correct the systematic $\Delta \phi_s$ error of current

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observations, the random errors remaining may be estimated provisionally in the order of 5 per cent. Figure 6 graphically compares the course made good as determined by Loran fixes with the dead reckoning of courses steered to counteract the anticipated drift by measured currents.

Multiple Sea Sampler

Six multiple sea samplers have been manufactured by our machine shop. One has been sent to the Admiralty Research Laboratory, Teddington, England for use aboard its vessel, DISCOVERY II. It is planned to sell or loan the remaining samplers to interested oceanographic laboratories located in this country and in Canada. These samplers have been built by Institution, not Government funds.

Assistance to the Hydrographic Office

Three groups of enlisted personnel (five men in each group) have received a week's training in the laboratory and in local waters on the operation of the bathythermograph, accurate presentation of the ships track and temperature profiles in connection with project AMOS

Eight Phleger Core Samplers are being manufactured in our machine shop for the Oceanographic Division, Hydrographic Office. This order is approaching completion.

Assistance to the Naval Research Laboratory

The temperature and salinity data collected on board the U.S.S. MALOY and PCE 849 in the Bermuda triangle during the previous quarter were completed and forwarded to the Naval Research Laboratory.

This work was carried out by Mr. Miller.

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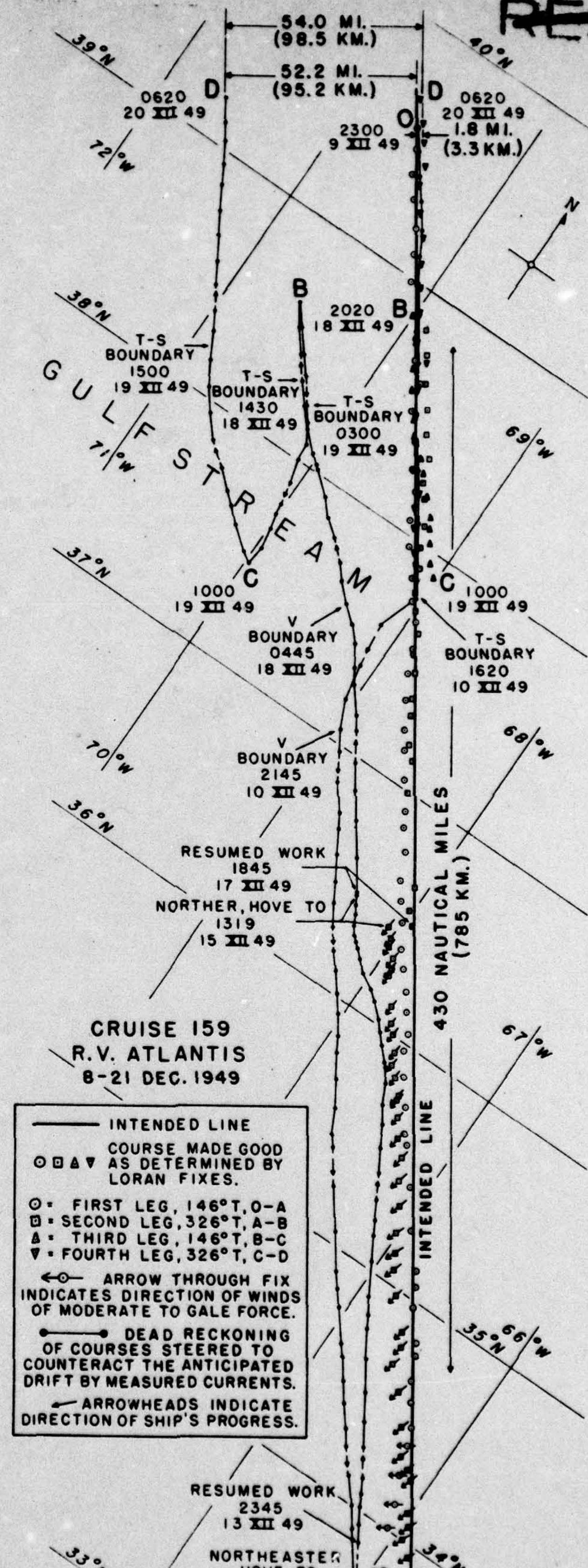

FIG. 6

PERSONNEL

ASSIGNMENT	NAME	TITLE	TOTAL MAN DAYS*
GENERAL TASK ASSIGNMENT	C. O'D. Iselin**	Director	
	A. C. Redfield	Associate Director	
	F. C. Ryder	Assistant to the Director	
	Jeanne M. Backus	Secretary	
			57½
HYDROGRAPHIC OBSERVATIONS AND ANALYSES	Robert Abel	Chemist	
	Dean Bumpus	Oceanographer	
	Carlyle Hayes	Hydrographic Technician	
	Frank J. Mather III	Research Associate	
	W. G. Metcalf	Research Associate in Arctic Oceanography	
	Arthur Miller	Research Associate	
	David M. Owen	Hydrographic Technician	
	Martin J. Pollak	Physical Oceanographer	
	L. V. Worthington	Hydrographic Technician	
			461½
CURRENTS AND WAVES	Louise Allen	Laboratory Helper	
	Ruth Barker	Technician	
	Richard Dimmock	Technician	
	Louise Dudley	Secretary-Technician	
	Thomas Duke	Research Assistant	
	Henry Hall	Technician	
	Mary Hunt	Statistical Technician	
	Arthur Klebba	Research Associate	
	H. R. Seiwell	Physical Oceanographer	
	Henry Stommel	Physical Oceanographer	
	W. S. von Arx	Physical Oceanographer	
	Dorothy Yarnold	Laboratory Helper	
			585
PHOTOGRAPHY AND DRAFTING	G. G. Pasley	Draughtsman	
	Claude Ronne	Photographer	
	Eva Shelnut	Draughtsman	
	John Stimpson	Draughtsman	
			149½
MISCELLANEOUS SHOPWORK AND LABORATORY ASSISTANCE			296

* Man Day consists of 8 working hours.
** Time not included in figures for Man Days.

GRAND TOTAL 1549½